SEPSIS

Ryan Donlin, BSN, RN, CCRN
Flight Nurse – REACH 3/Napa, CA
Objectives

• Review the basics of sepsis pathophysiology
• Review and discuss the evolution of sepsis as defined by the healthcare community
• Examine the early screening, identification and treatment pathways for sepsis
Objectives (cont.)

• Explore ways to fine tune treatment for sepsis patients requiring ICU level care

• Analyze the treatment differences for the pediatric population

• Recognize the psychosocial impacts of sepsis on both the patient and family
SEPSIS

• A syndrome of physiologic, pathologic, and biochemical abnormalities induced by infection
• A normal inflammatory response that has gone overboard
• Major public health concern, accounting for more than $20 billion (5.2%) of total US hospital costs in 2011
Contributing Factors

- Larger aging population with more co-morbidities
- Increased recognition
- Rise in invasive procedures, immunosuppressive drug use, chemotherapy, and organ transplants
- Increasing antibiotic resistance
Impact of Sepsis

• Patients who survive sepsis often have long-term physical, psychological, and cognitive disabilities with significant health care and social implications.

• Sepsis is a leading cause of mortality and critical illness worldwide.
Pathophysiology

An inflammatory stimulus
Production of proinflammatory mediators.
Numerous cytokines.

Engulfing the Enemy
Neutrophil–endothelial cell adhesion

Activate the clotting mechanism
Microthrombi

Opposed by anti-inflammatory mediators
a negative feedback mechanism.

Shunting + Capillary Obstruction (micro thrombi) = decreased delivery of $O_2$ and impaired removal of $CO_2$ and waste

Organ dysfunction and failure

Vasoactive mediators cause blood flow to bypass capillary exchange vessels (a distributive defect)

Late Sign
Cardiac output increases Later decrease BP falls

arteries and arterioles dilate
decreasing peripheral arterial resistance

Sepsis
Severe Sepsis
Septic Shock

A Salvaging Attempt
Dynamic time-course of the inflammatory response during sepsis
Sepsis Definition Timeline
1991: Sepsis-1

• *Sepsis* results from a host’s systemic inflammatory response syndrome (SIRS) to infection
  – Two or more of (SIRS Criteria)
    • Temperature >38°C or <36°C
    • Heart rate >90/min
    • Respiratory rate >20/min or PaCO₂ <32mmHg
    • White blood cell count >12 000/mm³ or <4000/mm³ or >10% immature bands
1991: Sepsis-1

- **Severe Sepsis** - complicated by organ dysfunction
- **Septic Shock** - induced hypotension persisting despite adequate fluid resuscitation

**SIRS**
Temp. $>38^\circ$C or $<36^\circ$C, HR $>90$, RR $>20$ or $\text{PaCO}_2 < 32$, WBCs $>12,000$ or $<4,000$ or $>10\%$ bands
2001: Sepsis-2

- Task force gathered due to recognized limitations of sepsis criteria
  - Result = expanded the list of diagnostic criteria

- **Sepsis** =
  - General +
  - Hemodynamic +
  - Inflammatory +
  - Organ Dysfunction +
  - Tissue Perfusion Parameters

- **Septic Shock** - a state of acute circulatory failure
2012 – Sepsis 2.1

Surviving Sepsis Campaign

Expanded SIRS Criteria

+ Suspicion of infection

(does not need to be confirmed/proven)

= SEPSIS Criteria
2016: Sepsis-3

- Sepsis (new definition)
  - a life-threatening organ dysfunction caused by a dysregulated host response to infection
  - SIRS and Severe Sepsis are no more for adults
2016: Sepsis-3 & SOFA

- **Organ Dysfunction** - identified as an acute change in total SOFA
  - Sequential [Sepsis-Related] Organ Failure Assessment

*QSOFA*

- Hypotension
  - Systolic BP <100 mmHg
- Altered Mental Status
- Tachypnea
  - RR >22/Min

Score of 22 Criteria Suggests a Greater Risk of a Poor Outcome
# National Early Warning Score (NEWS)

<table>
<thead>
<tr>
<th>PHYSIOLOGICAL PARAMETERS</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiration Rate</td>
<td>≤8</td>
<td>9 - 11</td>
<td>12 - 20</td>
<td>21 - 24</td>
<td>≥25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen Saturations</td>
<td>≤91</td>
<td>92 - 93</td>
<td>94 - 95</td>
<td>≥96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Supplemental Oxygen</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>≤35.0</td>
<td>35.1 - 36.0</td>
<td>36.1 - 38.0</td>
<td>38.1 - 39.0</td>
<td>≥39.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic BP</td>
<td>≤90</td>
<td>91 - 100</td>
<td>101 - 110</td>
<td>111 - 219</td>
<td>≥220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Rate</td>
<td>≤40</td>
<td>41 - 50</td>
<td>51 - 90</td>
<td>91 - 110</td>
<td>111 - 130</td>
<td>≥131</td>
<td></td>
</tr>
<tr>
<td>Consciousness Level</td>
<td>A</td>
<td>V, P, or U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* a weighting score of 2 should be added for any patient requiring supplemental oxygen
**Chart 1: National Early Warning Score (NEWS)**

<table>
<thead>
<tr>
<th>PHYSIOLOGICAL PARAMETERS</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiration Rate</td>
<td>≤8</td>
<td>9 - 11</td>
<td>12 - 20</td>
<td>21 - 24</td>
<td>≥25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen Satuations</td>
<td>≤91</td>
<td>92 - 93</td>
<td>94 - 95</td>
<td>≥96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Supplemental Oxygen</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>≤35.0</td>
<td>35.1 - 36.0</td>
<td>36.1 - 38.0</td>
<td>38.1 - 39.0</td>
<td>≥39.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic BP</td>
<td>≤90</td>
<td>91 - 100</td>
<td>101 - 110</td>
<td>111 - 219</td>
<td>≥220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Rate</td>
<td>≤40</td>
<td>41 - 50</td>
<td>51 - 90</td>
<td>91 - 110</td>
<td>111 - 130</td>
<td>≥131</td>
<td></td>
</tr>
<tr>
<td>Level of Consciousness</td>
<td>A</td>
<td>V, P, or U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The NEWS initiative flowed from the Royal College of Physicians’ NEWSDIG, and was jointly developed and funded in collaboration with the Royal College of Physicians, Royal College of Nursing, National Outreach Forum and NHS Training for Innovation.*

**qSOFA score:**
- Altered mental status
- Respiratory rate ≥ 22
- Systolic blood pressure ≤ 100
Sepsis 3

Patient with suspected infection

qSOFA ≥2? (see A)

No

Sepsis still suspected?

No

Monitor clinical condition; reevaluate for possible sepsis if clinically indicated

Yes

Assess for evidence of organ dysfunction

SOFA ≥2? (see B)

No

Monitor clinical condition; reevaluate for possible sepsis if clinically indicated

Yes

Sepsis

Despite adequate fluid resuscitation, 1. vasopressors required to maintain MAP ≥65 mm Hg AND 2. serum lactate level >2 mmol/L?

No

Yes

Septic shock

A qSOFA Variables
- Respiratory rate
- Mental status
- Systolic blood pressure

B SOFA Variables
- PaO₂/FiO₂ ratio
- Glasgow Coma Scale score
- Mean arterial pressure
- Administration of vasopressors with type and dose rate of infusion
- Serum creatinine or urine output
- Bilirubin
- Platelet count
Sepsis 3

- **Septic Shock** (new definition)- subset of sepsis in which underlying circulatory and cellular/metabolic abnormalities are profound enough to substantially increase mortality

- Clinical Indicators
  - Persisting hypotension requiring vasopressors to maintain MAP > 65mmHg &
  - Serum lactate level >2 mmol/L (18mg/dL) despite adequate volume resuscitation
SSC Response to Sepsis-3

• As of March 1, 2016
• Utilize 2012 Surviving Sepsis Campaign recommendations + new qSOFA/SOFA scoring system
  – tool for identifying patients at risk of sepsis with a higher risk of hospital death or prolonged ICU stay both inside and outside critical care units.
**BASIC Breakdown**

\[ \text{Sepsis} = \text{suspected infection} + \text{SOFA} + \text{qSOFA} \]

**Sepsis I-II:**

\[ \text{Sepsis} = [\text{Suspected infection}] + [\text{SIRS}] \]

**Sepsis-III:**

\[ \text{Sepsis} = [\text{Suspected infection}] + [\text{qSOFA}] + [\text{SOFA}] \]

- **Infection indicator**
- **Mortality indicators**
SO WHERE DO WE GO FROM HERE???

Recommendation is early screening, early identification, and early treatment
**Step 1:** Screen to Identify Infection

- Suspicion of infection (qSOFA)
  - Having 2 of 3 factors

- Hypotension: Systolic BP <100 mmHg
- Altered Mental Status
- Tachypnea: RR >22/Min

Score of >2 Criteria Suggests a Greater Risk of a Poor Outcome
What if I’m Prehospital EMS?

• Utilize qSOFA assessment criteria + pt history (especially recent illness/fever) to help identify need for early intervention

• The prehospital phase of care is a vital opportunity for early fluid admin/resuscitation mgmt
  – 20-30ml/kg crystalloid fluid bolus
  – Don’t delay IV start…if nothing looks good- Place IO and get fluid boluses going.
What if I’m Prehospital EMS?

• Placement of IV and IVF admin was associated with a significant reduction in the odds of hospital mortality compared to no fluid or IV access among severe sepsis patients.

• Early mgmt of hypotension (MAP < 65) is key to tissue perfusion
  – If protocols allow, start vasoactive medications early if resuscitation is ineffective.
Prehospital Sepsis Screening and Action Tool

Sepsis is a time critical condition. Screening, early intervention and immediate treatment saves lives. This tool should be applied to all adult patients who are not pregnant who have a suspected infection or their clinical observations are outside of normal limits.

1. Are any 2 of the following present?
   - Temperature > 38.3°C or < 36°C
   - Respiratory rate > 20 per minute
   - Heart rate > 90 per minute
   - Acute confusion/ reduced conscious level
   - Glucose > 7.7 mmol/l (unless DM)

   Y

   Sepsis present
   - Transport to designated destination.
   - Communicate presence of sepsis at handover

   Z
   - Sepsis not present
   - Treat to standard protocols

2. Could this be a severe infection?
   - For example:
     - Pneumonia
     - Urinary Tract Infection
     - Abdominal pain or distension
     - Meningitis
     - Cellulitis/ septic arthritis/ infected wound

   Z
   - Red Flag Sepsis
     - This is a time critical condition, immediate action is required.
     - Resuscitation:
       - 250ml boluses crystalloid to maximum 2000ml (care in CHD)
       - Oxygen 15L/min NRB (care in COPD)
       - Intravenous antibiotics (if available)
       - Record lactate (if available)

   Y
   - Communication:
     - Pre-alert receiving hospital of Red Flag Sepsis
     - Divert to the Emergency Department
     - (or other agreed destination)
     - Handover presence of Red Flag Sepsis

Z

3. Is any red flag present?
   - Systolic B.P < 90 mmHg
   - Lactate > 2 mmol/l
   - Heart rate > 130 per minute
   - Respiratory rate > 25 per minute
   - Oxygen saturations < 91%
   - Responds only to voice or pain/ unresponsive
   - Purpuric rash

   Y

   Red Flag Sepsis

   Z

THE UK SEPSIS TRUST
**Step 1: Screen to Identify Infection**

- Obtain at least 2 sets of blood cultures (both aerobic and anaerobic bottles) before antimicrobial therapy.

Administering broad-spectrum antibiotics as appropriate within 1hr of suspected sepsis.
## Example of Empiric Regimens

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Preferred Regimen</th>
<th>Alternative Regimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septic-shock Community-acquired</td>
<td>Vancomycin + Piperacillin/tazobactam (Zosyn®) or Ertapenem</td>
<td>Vancomycin + Aztreonam or Tobramycin + Metronidazole</td>
</tr>
<tr>
<td>Septic-shock Healthcare-associated (prior antibiotic use)</td>
<td>Vancomycin + Meropenem +/- Tobramycin</td>
<td>Vancomycin + Aztreonam + Tobramycin + Metronidazole</td>
</tr>
</tbody>
</table>

Table adapted from: UCSF Infectious Disease Management Program: [http://clinicalpharmacy.ucsf.edu/idmp/guide_home.htm](http://clinicalpharmacy.ucsf.edu/idmp/guide_home.htm)
**ABX: Order of Administration**

- **Gram-negative coverage**
  - Piperacillin/tazobactam
  - Meropenem
  - Aztreonam

- **Gram-positive coverage**
  - Vancomycin
  - Linezolid

- **Double gram-negative coverage and/or antifungal coverage and/or misc.**
  - Tobramycin (gram-neg)
  - Metronidazole (anaerobic)
  - Caspofungin (antifungal)

- May infuse over 30 minutes
- Vancomycin is infused ≥ 1 hour
Step 2: Screen for Organ Dysfunction

Baseline Sequential [Sepsis-related] Organ Failure Assessment (SOFA)
### Step 2: SOFA

#### Table 1. Sequential [Sepsis-Related] Organ Failure Assessment Score

<table>
<thead>
<tr>
<th>System</th>
<th>Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pao₂/Fio₂, mm Hg (kPa)</td>
<td>≥400 (53.3)</td>
<td>&lt;400 (53.3)</td>
<td>&lt;300 (40)</td>
<td>&lt;200 (26.7) with respiratory support</td>
<td>&lt;100 (13.3) with respiratory support</td>
<td></td>
</tr>
<tr>
<td><strong>Coagulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelets, x10³/μL</td>
<td>≥150</td>
<td>&lt;150</td>
<td>&lt;100</td>
<td>&lt;50</td>
<td>&lt;20</td>
<td></td>
</tr>
<tr>
<td><strong>Liver</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilirubin, mg/dL (μmol/L)</td>
<td>&lt;1.2 (20)</td>
<td>1.2-1.9 (20-32)</td>
<td>2.0-5.9 (33-101)</td>
<td>6.0-11.9 (102-204)</td>
<td>&gt;12.0 (204)</td>
<td></td>
</tr>
<tr>
<td><strong>Cardiovascular</strong></td>
<td>MAP ≥70 mm Hg</td>
<td>MAP &lt;70 mm Hg</td>
<td>Dopamine &lt;5 or dobutamine (any dose)</td>
<td>Dopamine 5.1-15 or epinephrine ≤0.1 or norepinephrine ≤0.1</td>
<td>Dopamine &gt;15 or epinephrine &gt;0.1 or norepinephrine &gt;0.1</td>
<td></td>
</tr>
<tr>
<td><strong>Central nervous system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glasgow Coma Scale score</td>
<td>15</td>
<td>13-14</td>
<td>10-12</td>
<td>6-9</td>
<td>&lt;6</td>
<td></td>
</tr>
<tr>
<td><strong>Renal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine, mg/dL (μmol/L)</td>
<td>&lt;1.2 (110)</td>
<td>1.2-1.9 (110-170)</td>
<td>2.0-3.4 (171-299)</td>
<td>3.5-4.9 (300-440)</td>
<td>&gt;5.0 (440)</td>
<td></td>
</tr>
<tr>
<td>Urine output, mL/d</td>
<td>&lt;500</td>
<td></td>
<td></td>
<td>&lt;200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: Fio₂, fraction of inspired oxygen; MAP, mean arterial pressure; Pao₂, partial pressure of oxygen.

a Adapted from Vincent et al.27

b Catecholamine doses are given as μg/kg/min for at least 1 hour.

c Glasgow Coma Scale scores range from 3-15; higher score indicates better neurological function.
SEPSIS CLINICAL CRITERIA

INFECTION + CHANGE IN:

Sepsis-Related Organ Failure Assessment

≥2

PaO₂/FiO₂, ARDS

PaO₂/FiO₂, Hypotension or Vasopressors

Glasgow Coma Scale, Platelets

Bilirubin, Creatinine, Oliguria
Step 3: Identification and Mgmt of Initial Hypotension

- MAP < 65mmHg and/or serum Lactate > 4mmol/L
- **Treatment**
  - 20-30ml/kg Crystalloid fluid resuscitation
- **Evaluate** - reassessment of volume responsiveness or tissue perfusion
Quick Review: 3hr Sepsis Bundle Goal

**Step 1:** Early Screen to identify infection
- *qSOFA* + Labs (Rainbow Panel) + Blood Cultures, then…
- ABX w/in 1hr of suspected infection; broad spectrum until cultures return

**Step 2:** Early Screen for organ dysfunction or for patients at risk (SOFA)

**Step 3:** Early mgmt of initial hypotension
- MAP > 65mmHg or Lactate > 4mmol/L
  - 20-30ml/kg crystalloid fluid
Lactate...to be used as a tool

• Lactate production in septic shock is not due to anaerobic metabolism or low oxygen delivery.
  – It is largely driven by endogenous epinephrine stimulating aerobic glycolysis via beta-2 adrenergic receptors.

• An elevated lactate should not be blindly used as a trigger to increase oxygen delivery.
Lactate (cont.)

- Elevated lactate is useful to identify occult shock – patients who are being maintained by a robust endogenous catecholamine release.

- These patients are at increased risk for deterioration and require more aggressive care.
Goal to Prevent

Death Spiral of Shock

- Vasoplegia
- 3rd space fluid extravasation

Myocardial dysfunction

- Release of vasodilators (i.e. nitric oxide)
- Systemic inflammation

Tissue hypoperfusion
**Press the Gas!!!**

- MAP > 65mmHg
- Vasopressor
- Time!

**Rapid support of MAP in septic shock**

1. **Septic shock with inadequate MAP**
   - Immediate noninvasive evaluation of fluid responsiveness (i.e., echo)
   - **Fluid-responsive**
     - Assess severity of septic shock & expected clinical course
       - **Mild shock**
         - Expected to resolve rapidly
         - MAP mildly low
         - Volume resuscitation only
       - **Severe shock**
         - Not expected to resolve rapidly
         - MAP severely low
         - Simultaneous volume resuscitation & norepinephrine
   - **Not fluid-responsive**
     - Start vasopressor and/or inotrope
   - Reassess, start norepinephrine if not responding to fluid
   - Reassess, wean norepinephrine if responds to fluid
Other Vasoactive Agents

- **Epinephrine** mcg/kg/min
- **Vasopressin** 0.04 units/minute
  - can be added to Norepinephrine (NE) with intent of either raising MAP or decreasing NE dosage
- **Dopamine**
  - alternative vasopressor agent to NE only in highly selected patients
    - eg, patients with low risk of tachyarrhythmias and absolute or relative bradycardia
Inotropic Therapy?

• A trial of **Dobutamine** infusion up to 20mcg/kg/min can be administered or added to vasopressor (if in use) in the presence of
  – (a) myocardial dysfunction as suggested by elevated cardiac filling pressures and low cardiac output, or
  – (b) ongoing signs of hypoperfusion, despite achieving adequate intravascular volume and adequate MAP

• Warning – Addition of Dobutamine will reduce afterload.
Overall goals within first 6hrs
(6hr Bundle Therapy)

THE SEPSIS SIX
Patient Required Intubation and Ventilator support...

• **What extra goals are there now?**
  
  – If ARDS criteria meet (P/F ratio – mild < 300, moderate < 200, severe < 100)
  – Target tidal volume 6ml/kg per IBW
  – Plateau Pressure < 30cmH20

*iSepsis- “Less is More”: The New paradigm in Critical Care*
PEEP This

- Always have PEEP support – may need high PEEP strategies with moderate/severe ARDS
- Goal is to prevent alveolar collapse and promote lung recruitment
- REACH ETT clamping protocol*
Still Intubated?

- HOB > 30-45 degrees + Oral chlorhexidine gluconate to reduce the risk of ventilator-associated pneumonia (VAP) in ICU pts w/ sepsis
- Prone Positioning?
- Conservative fluid resuscitation strategy!
ICU Time!

- Antibiotics: Early administration
- Fluids: Several liters initially
  - Colloids
  - Crystalloid
  - Starches
  - High chloride
- Vasopressors: 1–6 hours after onset
  - Norepinephrine
  - Epinephrine
  - Vasopressin
  - Dopamine
  - Phenylephrine
- Enteral feeding
- Insulin therapy
- Deep sedation
- Molecular targeted therapies
- Lung protective ventilation
- Goal oriented therapy
- EGDT: Early goal directed therapy
- Urinary catheter

Designed by: Will Stahl-Timmins
© 2016 BMJ Publishing group Ltd.
Let’s fine-tune the care: Misc. therapy goals

Endocrine –

• Glycemic control < 180 mg/dL
  – Consider insulin management therapy if Glucose >180mg/dL x2 consecutive checks

• Corticosteroids –
  – not recommended for the treatment of sepsis in Adults if fluid resuscitation is adequate
Flush the pipes

Renal

• CRRT = intermediate HD in patients w/ sepsis & ARF
  – CRRT would be more beneficial in patients with hemodynamic instability

• Sodium Bicarbonate
  – not recommended to improve hemodynamics as it may actually induce lactic acidemia
Feed Me!

**Nutrition**

- Feed the gut!
  - PO/Enteral, as tolerated, rather than either complete fasting or provision of only IV glucose within the first 48 hours after diagnosis

- Low dose feeding (e.g. up to 500 cals/day) during the first week
  - Advance as tolerated
Body & Mind

Psych-Social

• Discuss and set goals of care with patients and family as early as possible
  – Especially if ICU admission is required, within first 72hrs

• Incorporate Palliative Care principles where appropriate and include goals of care in treatment plan
Be the Detective

Locate/control the source of infection

• If intravascular access devices are a possible source, remove them promptly after other vascular access has been established

• Utilize least invasive effective means as interventions for source control first.
  – IR vs. Surgical approaches
Pediatric Population
“They’re not just tiny adults”

- There is no equivalent to qSOFA/ SOFA yet adopted in the U.S. so we may still see SIRS used for Pedi
- Two or more of (SIRS Criteria)
  - Temperature >38C or <36C
  - Heart rate > 2SD above normal for age
  - Respiratory rate > 2SD above normal for age
  - Abnormal WBC count or >10% immature bands
**Pediatric Considerations**

- Treatment is similar to that of adults but with some subtle differences
  - Perfusion- **Warm** vs. **Cold** (peripheral vasodilatation vs. vasoconstriction)
    - **Warm** - wide pulse pressure, bounding pulses, warm extremities
    - **Cold** - narrow pulse pressure, weak pulses, cold extremities due to shunting to vital organs
Pediatric Considerations (cont.)

- Fluid Resuscitation - rapid delivery and reassessment
  - 20ml/kg crystalloid via “push-pull” manual method
  - May require up to 60ml/kg total fluid within first hour
Pediatric Considerations (cont.)

• Don’t hold out on vasoactive therapy, but make the right choice
  – Patient remains hypotensive after reaching 60ml/kg fluid resuscitation

• **Cold shock** (SvO2 < 70%) – Epinephrine

• **Warm shock** (SvO2 > 70%) – NorEpi; consider adding Vasopressin

• **Normotensive Cold shock** (SvO2 < 70%)
  – impaired perfusion but normal BP
  – low dose Epinephrine + consideration of Milrinone/Dobutamine
Pediatric Considerations (cont.)

- **Hypoglycemia**
  - Neonates < 45 mg/dL; Infants/Children < 60 mg/dL
    - Often an early indicator of adrenal insufficiency

- **Hyperglycemia**?

- **Hypocalcemia**
  - Infants < 12 months of age may rely more heavily on extracellular calcium to maintain adequate cardiac contractility than older patients
Pediatric Considerations (cont.)

• Filled the tank and pressed the gas but refractory shock remains
  – Consider Adrenal insufficiency-
    • 25-30% septic Pedi will have adrenal insufficiency known as Waterhouse-Friderichsen syndrome
  – Hydrocortisone 1mg/kg bolus (max 100mg)

• Blood transfusion considered for Hgb < 10 g/dL
Pediatric Considerations (cont.)

• Airway - provide 100% O2 via high flow (15L)
  • Utilize non-invasive support if needed
    – CPAP/Bi-Level Positive Airway Pressure
    – Bubble CPAP (<10kg)
Case Study #1 – “My Tummy Hurts”

- 3yr old previously healthy kiddo with c/o vomiting for 2 days w/ fever. Tmax – 38.8°C over the last 24hrs
- Seen yesterday by PCP and sent home with Tylenol with working diagnosis of “stomach virus” per Mom
- PMH – none
- Allergies – NKDA
- Medications – Tylenol PRN
- Family history – lives with both parents, older brother at home with runny nose and cough
Case Study #1 (cont.)

Primary survey/general appearance

- Ill appearing, drowsy, cries with stimulated
- Patent airway but rapid/shallow breathing pattern
- Pale skin tone, mottled distal extremities

Initial Vitals

<table>
<thead>
<tr>
<th>HR 166</th>
<th>BP 89/49 (62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR 34</td>
<td>SPO2 – 91%</td>
</tr>
<tr>
<td>Temp 35.3</td>
<td></td>
</tr>
</tbody>
</table>
Case Study #1 (cont.)

- Secondary Survey/Exam (notables)
  - Poor cooperation w/ neuro exam, not oriented to place
    - Repeatedly says he’s at home
  - Nasal congestion w/ “crusties”, dry mucus membranes
  - Diffuse ABD tenderness, mild guarding noted when palpated
  - Cool, mottled extremities, Cap Refill > 4sec

- Notable labs –
  - FSBG 70, CO2 12, Anion gap 31, Cr 1.30
  - WBC 4.5 (0% Neutrophils / 89% Lymphocytes)
Case Study #1 (cont.)

• Working diagnosis for patient?
  – How sick is this patient?

• Critical concerns with regards to initial assessment and diagnostics?
  – Common manifestation of sepsis in pediatric population?
  – Assessment of end organ function?
  – Cold vs Warm shock? Treatment pathway…

• Any other imaging or diagnostics would you want completed?
Case Study #2 – “What Lies Beneath”

- 71 YOF w/ c/o uncontrolled LLE leg pain r/t chronic Cellulitis and diabetic ulcers
- Pt describes increased swelling and “heat” around LLE over the last 3 days, in addition to discoloration “different than anything before”
- PMH – COPD, CHF, Afib, DM Type II, HTN, HLD, Obesity, Smoker, ESRD w/ Dialysis
- PSH – Knee replacement, Ulcer debridement to bilateral feet,
- NKDA
Case Study #2

Vital Signs –

- HR – 101 (Afib)
- BP – 107/71
- RR – 31
- SPO2 – 90% RA
- Temp – 39.1°C
- Pain – 8/10

- Pt describes decreased intake over the last 72hrs.
Case Study #2 (cont.)

- What are our first steps upon ED admission?
- What could the working diagnosis be for this patient?
- Treatment needed to prevent further infection?
Case Study #3 – “The Brad”

- Brad is a 34YOM who sustained a stab wound to the left flank approx. 9 days ago following a “minor” dispute at a bar.

- Based off of the ABD-CT scan and MD eval, no surgical intervention was required r/t the initial injury.

- Brad was released home with pain meds and oral ABX.
“The Brad” (cont.)

- Brad returned to the ED by family vehicle w/ a poor presentation stating that the stab wound “won’t stop oozing” and “I can’t keep anything down”.

- **PMH** – Smoker; **PSH** – none; **NKDA**

- **Home Meds** – “just vitamins”

- **Vital Signs** –
  - HR: 103; **BP**: 96/62 (73); **RR**: 24; **SPO2**: 93% RA; **TEMP**: 35.8°C
  - Pain: 8/10; **LOC**: A0x4

- **Working Dx** – Hypovolemic shock, Dehydration, Possible Bowel Injury
“The Brad” (cont.)

- Brad was immediately prepped and sent to the OR for an Ex Lap

- **Anesthesia Report**
  - Intubated w/ 8.0 cuffed ETT for procedure
  - Meds: Sevoflurane, Sodabic, Fentanyl, **Etomidate**, Nimbex, Robinul, Phenylephrine, Zosyn, Vancomycin, Norepinephrine
  - IVF: 4,000ml LR
  - EBL: minimal
  - UO: 2,300ml

- **Surgical Report**
  - 2 small bowel perforations: Resection + Primary anastomosis, NGT to LIWS
“The Brad” (cont.) – To the ICU!!

• Post Op ICU recovery phase was unremarkable until POD #3

• Brad slowly began to require and increase in pain mgmt meds, decreasing hourly urine output, liable BPs during rest, and a low grade fever

• F/u ABD CT-scan and return to the OR theater revealed anastomotic leak and peritoneal abscess

• S/p procedure #2, Brad was difficult to wean from the vent d/t the development of ARDS stemming from aggressive fluid mgmt & AKI.
“The Brad” – Finale

• Brad’s total LOS in the hospital = 31 days
  – Days requiring mechanical vent support – 13 days
  – OR procedures – 3

• Days away from the gym
  – 90 days
Take Home Concepts

- Sepsis is a life-threatening condition that arises when the body’s response to an infection injures its own tissues and organs.
- A normal inflammatory response that has gone overboard.
Take Home Concepts

• Sepsis is the primary cause of death r/t infection, especially if not recognized and treated promptly.

• Early recognition requires urgent attention especially in high risk populations
  – Neonates & Geriatric (> 85yrs) due to less physiologic reserve

GET AHEAD OF SEPSIS

KNOW THE RISKS. SPOT THE SIGNS. ACT FAST.
Take Home Concepts

• New Sepsis-3 clinical criteria/definitions especially qSOFA and SOFA are to be used as tools for predictors of mortality in a critically ill patient.

• Continue to be a clinical investigator for a variety of illnesses that may be present and use all the information collected as a guide to diagnosis and treatment
References


Surviving Sepsis Campaign

Weingart, S. www.EMCrit.org